SPACE SCIENCE BOARD
National Academy of Sciences
National Research Council
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SPACE PROBE STERILIZATION

During 1959 a special ad hoc group of the Space Science Board considered the subject of contamination of probes likely to impact the Moon or the planets. These considerations resulted in the adoption of a two-part recommendation which was transmitted to the Government in September 1959:

> "(1) that an immediate study program be undertaken to determine sterilization requirements for space probes and to develop recommendations, compatible with present design and assembly processes, regarding necessary sterilization procedures;
>
> (2) that procedures be immediately established and implemented to insure a complete inventory of all components of all space probes."

These recommendations formed the basis for studies of space vehicle sterilization by the National Aeronautics and Space Administration and resulted in NASA's general policy of "sterilizing, to the extent technically feasible, all space probes intended to pass in the near vicinity of or impact on the Moon or planets."

During the course of the 1962 Space Science Summer Study a working group of scientists and engineers together reviewed the three years of experience and reported its findings in "A Review of Space Research" (NAS-NRC Publication 1079, Chapter 10). As a result of this report and with additional information available to it, the Space Science Board has adopted a restatement of policy with regard to (1) lunar probes and (2) Mars probes.

The Moon

The lunar surface with its high temperatures, intense ultraviolet radiation, paucity of moisture, and high vacuum is a most unfavorable environment for proliferation of terrestrial organisms. Although

some forms could survive in protected places, they would be relatively immobile. Lunar subsurface conditions, in contrast, are relatively unknown. However, except at the site of impact, deep subsurface contamination from a lunar landing appears highly unlikely. Even so, the lunar exploration programs to date, both U.S. and Russian, have undertaken to minimize contamination in order to avoid depositing terrestrial organisms on the Moon; both of the probes which have impacted on the Moon are believed to have carried only a relatively small number of microorganisms. Nevertheless the deposition of terrestrial contaminants (viable or not) over portions of the lunar surface seems nearly certain. While this introduction of organic substances of terrestrial origin into the lunar surface seems at present unavoidable, we believe it continues to be undesirable. Minimizing contamination by future lunar impactors remains an important consideration from the scientific viewpoint. The chief purposes here are to avoid possible distortion of chemical evidence (e.g. by microbial action) which may bear on conditions which preceded the evolution of life and to preserve the deep layers uncontaminated for subsurface life-detection experiments.

In view of these considerations the Space Science Board recommends that the following policy be considered for spacecraft programmed to land on the Moon:

(i) Minimize contamination to the extent technically feasible. By appropriate selection of components (favoring those which are inherently sterile internally) and the use of surface sterilants it should be possible to achieve a cleanliness level to approximate that which prevails in most hospital surgery rooms.

(ii) Inventory all organic chemical constituents. This will permit the interpretation of analytical results from future collections of lunar material.

(iii) Accord a low priority to life-detection experiments by remote devices on the lunar surface. A high priority should be attached to sampling the subsurface at points removed from the immediate vicinity of any landing site.

(iv) Undertake the development of a sterile drilling system to accompany an early Apollo mission to return an uncontaminated sample of the lunar subsoil. Samples aseptically collected from this subsoil will be of both biological and geochemical interest. Should life exist on the Moon, it might be expected at some depth below the surface where temperatures never exceed 100°C and below the zone of ultraviolet radiation. Every effort should be made to keep this level free of contaminants until it can be sampled by drilling.

Mars

The planet Mars is by far the most probable extraterrestrial body in the solar system to be populated by forms of life. One of the most significant possible discoveries in space research, and perhaps even the most important, would be the finding of extraterrestrial life. Discovery of living organisms on Mars must depend on means of detection which could not be expected to distinguish between terrestrial contaminants and members of an indigenous Martian biota. Some terrestrial microorganisms are known to survive simulated Martian environmental conditions. Therefore the contamination of Mars through the impacting of nonsterile probes from the Earth could destroy an opportunity to carry out a meaningful search for life forms on Mars with remote detectors. This opportunity is unique and its loss would be a catastrophe: it is essential to preserve Mars until complete sterilization of the probes to land there has been achieved.

Moreover, should the initial life-detection experiments to be sent to Mars yield negative results, sterilization of Martian probes should not be abandoned automatically. There will remain scientific reasons for continuing to adhere rigidly to a policy of sterilization during the initial phases of sample collection from Martian surface and subsurface. If sterile, Mars will provide a unique opportunity to detect and analyze organic compounds of nonbiological origin in the Martian soil. Such studies of prebiological geochemistry, free from interference by living organisms, can supply important and otherwise not directly attainable information concerning the origins of life. Therefore contamination (introduction of viable terrestrial microorganisms) and pollution (introduction of significant amounts of terrestrial, albeit sterile, organic matter) are to be avoided until adequate soil sampling can be accomplished even if initial results from remote detectors suggest that Mars may have no biota.

In view of these considerations the Space Science Board recommends that the following policy be considered for spacecraft programmed to land on Mars:

(i) Accord the highest priority to the prevention of the biological contamination of Mars until sufficient information has been obtained about possible life forms there so that further scientific studies will not be jeopardized. Recognition of this priority on the part of launching nations is in accord with their main scientific objectives, in contrast to a competition to be first in which these objectives might be forever sacrificed.

(ii) Establish and provide adequate support for an augmented research program to develop agents, methods and techniques for the sterilization of Martian probes. Such a research program should mobilize both biologists and engineers to insure successful development of practical sterilization procedures.

(iii) Inventory all organic chemical constituents. This is precautionary, but the lack of an inventory might make impossible the interpretation of analytical results from future collections of Martian material.

(iv) Cooperate fully with all other nations in the protection of Mars against premature biological contamination. The exchange of information and the possibility of a joint research project between scientists of the USSR and the U.S. should be explored.

(v) Strengthen the current research program for the development of the best possible life-detection experiments to insure the incorporation of a life-detection experiment in the first Mars lander. This is of extreme importance for otherwise we may succeed in the sterilization of Mars probes but fail to accomplish our true objective.